

FLYING MACHINES.

ARCHED WINGS THE SECRET OF AERIAL FLIGHT.

A German Inventor Soared for Nearly Three Hundred Yards With the Apparatus He Has Constructed.

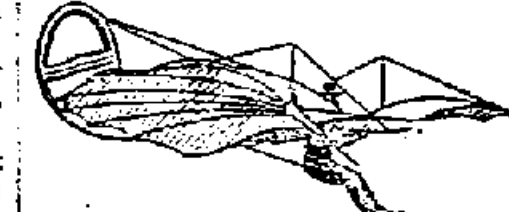


HE experience of the century and more which has elapsed since the invention of Montgolfier has taught us, says a Berlin letter to the New York Herald, that the balloon is of practical service only when confined.

The whims of the winds are too capricious to afford a trustworthy basis of procedure, and notwithstanding the expedients which the progress of science has made it possible to apply, all attempts to control a free balloon, or to guide it in any given direction, have thus far been unavailing, and we seem to be no nearer a satisfactory solution of the problem than were our predecessors of a hundred years ago. The attention of investigators has been diverted, therefore, to flying machines, like Professor Wilner's, and air ships, like Mr. Maxim's.

Herr Otto Lilienthal, of Berlin, who has some celebrity as "The Flying Man," has conducted a long series of experiments, which have at length been rewarded with an encouraging measure of success. Herr Lilienthal was born forty-six years ago in Anklam, near the Baltic coast of Pomerania, about sixty miles to the northwest of Stettin. A residence so near the sea afforded him in early life many opportunities of prosecuting his favorite studies and observations. In later years he migrated with his younger brother, Gustav, his enthusiastic conditor in all his researches, to Berlin, where he established and is now conducting a large manufactory of small steam engines, whose mechanical appliances furnish him with every facility for the construction of his flying apparatus. He resides, however, in the suburb Lichterfelde, and his late experiments have been conducted chiefly in the neighboring localities of Steglitz and the Heilower Bergen. He is an accomplished mathematician and a close observer of nature.

After many experiments with flat wings, or plane surfaces, Herr Lilienthal became convinced that it was the



THE MACHINE IN PRACTICAL USE.

gentle parabolic curve of the wing which enabled a bird to sustain itself without apparent effort in the air, and even to soar, without a motion of the wings, against the wind, like the albatross, or sea gull or stork; and this may be regarded as the most important outcome of Herr Lilienthal's investigations.

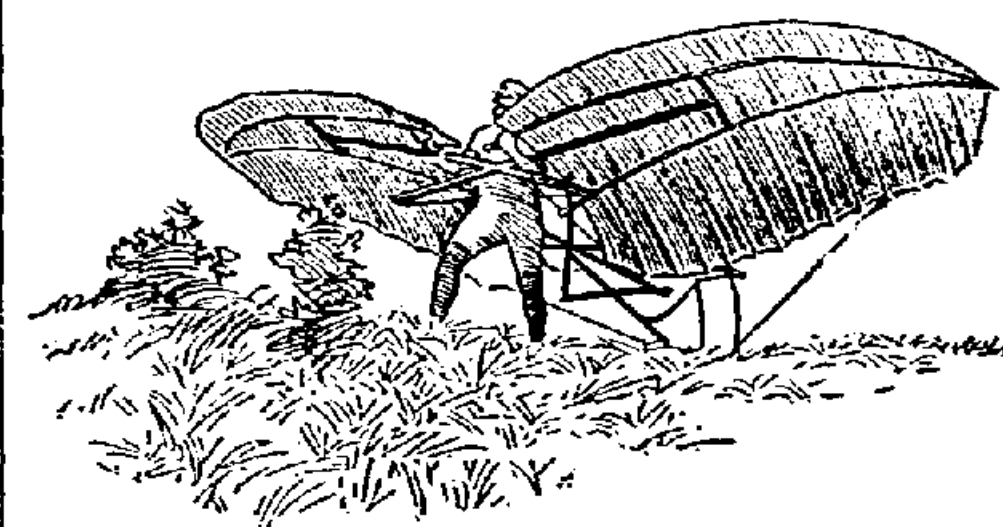
"Now that we possess diagrams," said Herr Lilienthal to me, "which plainly illustrate all these phenomena, it seems quite easy to explain the flight of birds, for every crow that flies over our heads offers a practical solution of the riddle. Recent researches into the laws of atmospheric resistance lead clearly to the deduction that curved or arched surfaces are to be preferred to flat ones. But the original discovery was by no means as simple and self-evident as it now appears. There are still prominent investigators who will not see that the arched or vaulted wing includes the secret of the art of flight. As we came upon the track of this idea, my brother and I, who were then young and wholly without means, used to spare from our breakfast, penny by penny, the money to prosecute our investigations; and often the struggle for life compelled us to interrupt them indefinitely.

"While we were devoting every moment of our spare time to the solution of the problem, almost every one in Germany regarded the man who would waste his energies in such unproductive labor as a fool. Years ago the most distinguished professor of mathematics in the Berlin Industrial Academy sent me word that of course it could do no harm to amuse myself with such pastimes, but warned me earnestly against putting any money into them.

"A special commission of experts, organized by the State, had in fact laid it down as a fundamental principle, once for all, that it was impossible for a man to fly. German societies for the promotion of aeronautics did not exist and those subsequently formed were devoted almost entirely to the interests of ballooning. There always regarded the balloon and the exclusive attention which it so attracted, as a hindrance rather than a

To the conviction that concave or vaulted wings were essential to success, Herr Lilienthal was led not only by the examination of a great variety of natural wings, and by theoretical deduction, but by actual experiment. The means adopted for this purpose were ingenious and simple. He fitted up an apparatus in the form of the "flybars" found on the dining tables of clubs and restaurants, with two long arms revolving horizontally, to the ends of which surfaces of different kinds and degrees of curvature could be affixed in any required position. The motive power was furnished by a weight and could be exactly measured. There was also an adjustment which enabled the observer to measure the lifting force of various surfaces moving at different angles of inclination through still air.

By this means Herr Lilienthal was



THE WINGS SPREAD FOR FLYING.

enabled to reach conclusions which were of great value to him in the construction of his flying machine, and the most important of them was that the most effective form of wing was that whose convexity, as measured by the versed breadth of the arc, should be one-twelfth of the breadth of the wing, or, of the length of the chord connecting the opposite edges.

The flying machine devised and now used by Herr Lilienthal is designed rather for sailing than for flying in the proper sense of the term, or, as he says, "for being carried steadily and without danger, under the least possible angle of descent, against a moderate wind, from an elevated point to the plain below. It is made almost entirely of closely woven muslin, washed with collodion to render it impervious to air, and stretched upon a ribbed frame of split willow, which has been found to be the lightest and strongest material for this purpose.

Its main elements are the arched wings, a vertical rudder, shaped like a conventional palm leaf, which acts as a vane in keeping the head always toward the wind, and a flat horizontal rudder to prevent sudden changes in the equilibrium. The operator so adjusts the apparatus to his person that when in the air he will be seated upon a narrow support near the front, and, with the wings folded behind him, makes a short run from some elevated point, always against the wind, and, when he has attained sufficient velocity, launches himself into the air by a spring or jump, at the same time spreading the wings, which are at once extended to their full breadth by atmospheric action, whereupon he sails majestically along like a gigantic seagull. In this way Herr Lilienthal has accomplished flights of nearly three hundred yards from the starting point.

"No one," said Herr Lilienthal to me, "can realize how substantial the air is until he feels its supporting power beneath him. It inspires confidence at once. If the wings were flat the speed might be greater, but the sustaining power would be reduced, and the descent would therefore be more rapid. With arched wings it is possible to sail against a moderate breeze at an angle of not more than six degrees to the horizon.

"The principle is recognized in the umbrella form universally adopted for the parachute. Try to run with an open umbrella held above the head and slightly inclined backward, and see what a lifting power it exerts. Soaring, in the sense of rising against the wind as the birds do, is possible only with the dome shaped wings. The aeroplane, or flat wing, when inclined at a certain angle to the breeze, may rise while its momentum continues, but this once overcome its power is gone, and nothing can restore it.

"In my long intercourse with the air and the winds, in all their varying phases, I have learned that there is an extraordinary category of difficulties to be overcome. In my trials of wings moved by the feet, in my attempts to construct steam flying machines and in my experiments with mechanical birds of every description I have discovered how difficult it is to maintain a steady position in the air, independent of the caprices of the winds. I, therefore, gave up for the time all efforts toward propulsion, and applied myself to the discovery of the simplest form of wing that would enable me to sail steadily through the air on a gentle incline, and by practice to master the wind, that hereditary foe of all aeronauts.

"I adhere firmly to my conviction that the wings must be slightly concave. This is the fundamental condition of success. The wings which I now use are in the main segments of a spherical surface. They are so constructed that they can be folded together like the wings of a bat and require very little storage room when not in use.

position of the centre of gravity as to restore the equilibrium.

"There are limits also to the breadth of the wings, or their extension backward. The operator must be able in a moment to transfer the centre of gravity so far to the rear as to overcome the action of the air, which might otherwise tend to throw him forward and precipitate him to the earth. It is not easy to realize in practice at first, but after a short experience the movement becomes almost involuntary."

"But is there not great danger," I asked, "of a serious fall in such cases?" "No," replied Herr Lilienthal. "When there is no wind the apparatus acts simply as a parachute. I have more than once found myself in this position, when I have utilized the speed obtained in gradual descent in rising to a greater height, to soar over

some obstacle like a tree or a crowd of people. Under favorable circumstances it is easy to mount to a height even greater than that of the starting point, but the forward motion is thereby partially or wholly neutralized, and it may happen that one comes to a complete standstill in mid-air. In such cases it is only necessary to throw the centre of gravity so far back that the air shall act more powerfully on the forward surface, and the gradual gliding descent is resumed. So, in landing, I bend backward exactly as a crow does when alighting in a field and reach the ground without the slightest shock. The worst that is likely to happen in any case is the breaking of the apparatus; there is little danger to life or limb.

"I am far from supposing that my wings, although they afford the means of sailing, and even of soaring in the air, possesses all the delicate and subtle qualities necessary to the perfection of the art of flight. But my researches show that it is well worth while to prosecute the investigations further, and in the end, perhaps, to realize the beau ideal of all modes of motion and to put it to practical account."

Having demonstrated the practicability of sailing and soaring, Herr Lilienthal has sought in his recent experiments to reach a practical solution of the problems of actual flight. The first difficulty to be overcome was the discovery of a suitable motor. Herr Lilienthal conceived the ingenious idea of employing, as a motive force, the vapor or liquid carbonic acid, which, under ordinary atmospheric pressure, boils at a temperature far below that at which mercury freezes. The engine devised by Herr Lilienthal required no fire, no boiler, nor steam chest—only a diminutive cylinder with the requisite valve arrangements, which may be readily worked by hand, and a small reservoir of the liquid acid lying close beside it.

The engine first constructed was of two horse-power, with a receiver to contain enough carbonic acid to last for two hours, and was attached to the front of the flying apparatus. The whole contrivance, with the necessary machinery to impart motion to the wings, added less than twenty-five pounds to the weight, and this will probably be reduced in future by the use of some alloy of aluminum instead of iron in the manufacture of the heavier portions. The wings were also fitted with rotary pinions capable of automatic action under the pressure of the air. The first experiments with this apparatus were rather too successful, at least in demonstrating the power of the engine. Unfortunately, the inventor had underestimated the



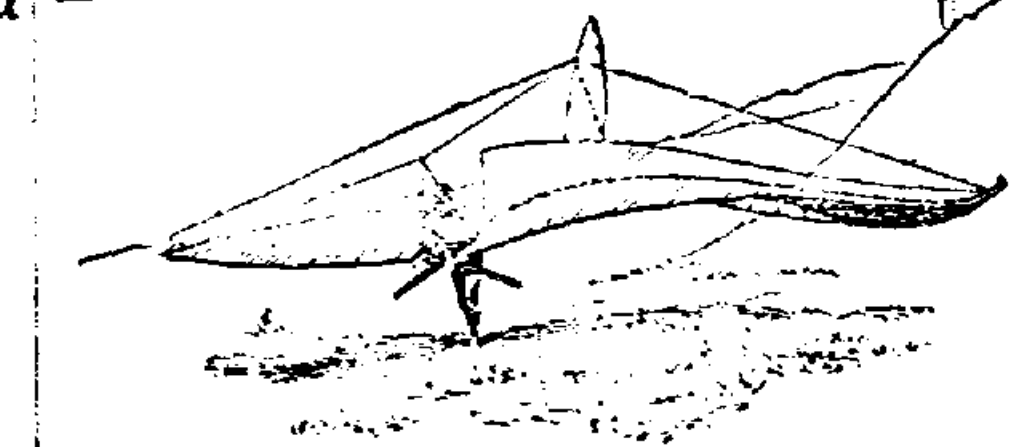
READY FOR A DESCENT.

energy of his motor, which acted with such unexpected vigor that the wings were broken, and the modifications thus shown to be necessary will require some time for their completion.

It is only by a series of trials that the proper relations between the various parts of the machine can be determined. Herr Lilienthal confidently expects, however, eventually to solve the problem in this way.

A Peculiar Electrical Effect.

An accident recently occurred at the power station of an electric railway to a large city, which caught all the ears. When the disaster was reported and the current turned on to the lines the circuit breakers all dropped, showing that the wires were overloaded. Again and again it was tried to get the lines in operation, with the same result. The difficulty was that every motor man, as soon as he found the current on, started his car, and the simultaneous demand from so many sources overloaded the wires. Riders were sent out to repress some of the cars, and so the system was got into motion. The wires were subsequently allowed to start.



JUST BEFORE THE ASCENT.

help to the development of the art of flight. If it had never been invented, it is probable that more serious investigations would have been prosecuted

It was only gradually that I arrived at the proper dimensions. Those which I now employ are never more than twenty-three feet from tip to tip, and are made by a simple